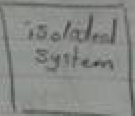
Date: 2/12/2015

Subject: lec thermo 8

Exergy (W)

$X_{destroyed} = S_{gen} T_0$

(S_{gen} → ⊕, T_0 → ⊕)



$\Delta X \leq 0$

$X_{destroyed} = ⊕$

$\Delta X = ⊖$

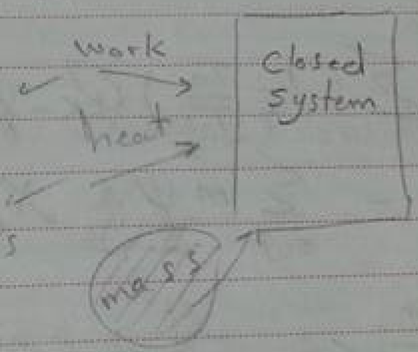
S_{gen} { > 0 actual process; = 0 reversible "; < 0 impossible "

$X_{destroyed}$ { > 0 actual pr; = 0 rev "; < 0 imp

Exergy balance : Closed system

Exergy (heat, work)

[illegible]



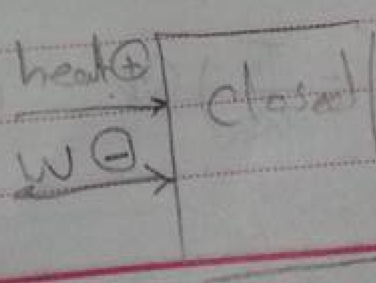
$X_{in} - X_{out} - X_{destroyed} = \Delta X_{sys}$

in the rate form :

$\dot{X}_{in} - \dot{X}_{out} - \dot{X}_{des} = \frac{dX_{sys}}{dt}$

→ $T_0 S_{gen}$ or $T_0 \dot{S}_{gen}$

$X_{heat} - X_{work} - X_{des} = \Delta X_{system}$



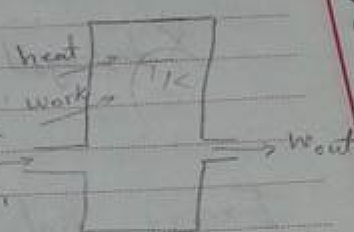
Subject : .... Date: ..../..../....

$$\sum \left(1-\frac{T_0}{T_k}\right) Q_k - \left(W - P_0 (V_2 - V_1)\right) - T_0 S_{gen} = X_2 - X_1$$

Rate form :

$$\sum \left(1-\frac{T_0}{T_k}\right) \dot{Q}_k - \left(\dot{W} - P_0 \frac{dV_{system}}{dt}\right) - T_0 \dot{S}_{gen} = \frac{dX_{system}}{dt}$$

Control Volume (open System)



$$X_{heat} - X_{work} + X_{mass,in} - X_{mass,out} - X_{des} = (X_2 - X_1)$$

Or

$$\sum \left(1-\frac{T_0}{T_k}\right) Q_k - \left[W - P_0 (V_2 - V_1)\right] + \sum_{in} m\psi - \sum_{out} m\psi - X_{destroyed} = (X_2 - X_1)_{c.v}$$

rate form

$$\sum \left(1-\frac{T_0}{T_k}\right) \dot{Q}_k - \left(\dot{W} - P_0 \frac{dV_{c.v}}{dt}\right) + \sum_{in} \dot{m}\psi - \sum_{out} \dot{m}\psi - \dot{X}_{destroyed} = \frac{dX_{c.v}}{dt}$$

For steady flow :

$$\sum \left(1-\frac{T_0}{T_k}\right) \dot{Q}_k - \dot{W} + \sum_{in} \dot{m}\psi - \sum_{out} \dot{m}\psi - \dot{X}_{destroyed} =$$

Date: ..../......../.........   Subject : ....

Steady flow - one stream :-

$$\dot{m} = \dot{m}_{in} = \dot{m}_{out}$$

$$\sum \left(1 - \frac{T_0}{T_K}\right) \dot{Q}_K - \dot{W} + \dot{m}\,(\psi_1 - \psi_2) - \dot{X}_{destroyed} = 0$$

$$\psi_1 - \psi_2 = (h_1 - h_2) - T_0 (S_1 - S_2) + \frac{V_1^2 - V_2^2}{2} + g(z_1 - z_2)$$

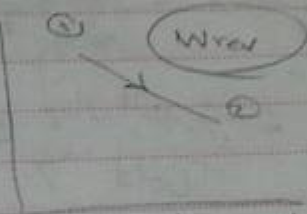
Per unit mass :-

$$\sum \left(1 - \frac{T_0}{T_K}\right) q_K - W + (\psi_1 - \psi_2) - X_{des} = 0 \quad KJ/kg$$

reversible work, W_{rev} :

$W = W_{rev}$ when $X_{des} = 0$

Single stream



$$\dot{W}_{rev} = \dot{m}\,(\psi_1 - \psi_2) + \sum \left(1 - \frac{T_0}{T_K}\right) \dot{Q}_K \quad Kwatt$$

Adiabatic Single stream :-

$$\dot{W}_{rev} = \dot{m}\,(\psi_1 - \psi_2)$$

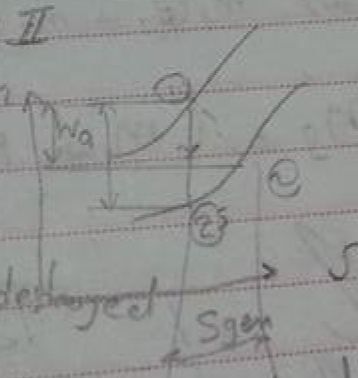
Second law efficiency of steady flow devices

$$\eta_{II} = \frac{\text{Exergy recovery}}{\text{Exergy supply}}$$

$$\eta_{II,turb} = \frac{W}{W_{rev}} = \frac{h_1 - h_2}{(\psi_1 - \psi_2)}$$

ke, pe

or $\eta_{II,turb} = 1 - \frac{T_0 S_{gen}}{\psi_1 - \psi_2}$ → $X_{destroyed}$



$W_{actual} =$

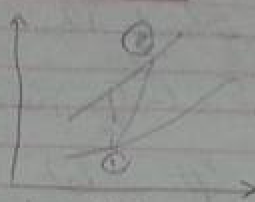
$$S_{gen} = S_2 - S_1$$

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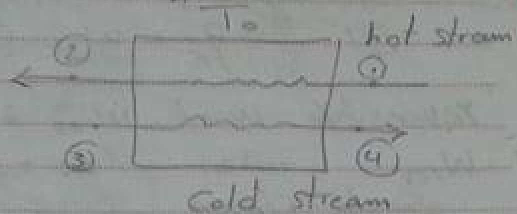
$$\eta_{II,Comp} = \frac{W_{rev,in}}{W_a} = \frac{\psi_2 - \psi_1}{h_2 - h_1}$$

$$\text{or } \eta_{II,Comp} = 1 - \frac{T_0 S_{gen}}{h_2 - h_1} \leftarrow S_2 - S_1$$



الأجهزة اللي بيشتغل

$$\eta_{II,HX} = \frac{\dot{m}_{cold}(\psi_4 - \psi_3)}{\dot{m}_{hot}(\psi_1 - \psi_2)}$$



غالباً الـ [illegible] ← $T_{cold} > T_{medium}$

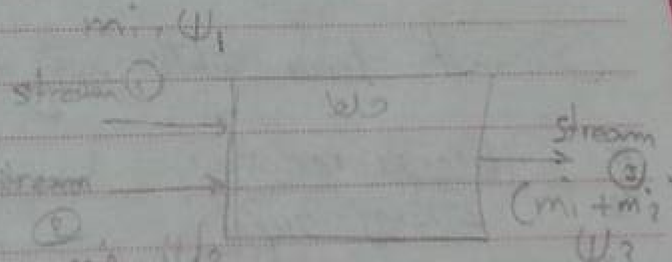
heat exchanger

المبادل الحراري

$$= 1 - \frac{T_0 S_{gen}}{\dot{m}_{hot}(\psi_1 - \psi_2)}$$

$$S_{gen} = \dot{m}_{hot}(S_2 - S_1) + \dot{m}_{cold}(S_4 - S_3)$$

$$\eta_{II,mix} = \frac{\dot{m}_3 \psi_3}{\dot{m}_1 \psi_1 + \dot{m}_2 \psi_2}$$



$$\dot{m}_3 = (\dot{m}_1 + \dot{m}_2)$$

mixing champer

$$\eta_{II} = 1 - \frac{T_0 S_{gen}}{\dot{m}_1 \psi_1 + \dot{m}_2 \psi_2}$$

Date: ..../......./........

Subject : ....

Ch.9 :- Power Cycle

thermodynamics

Power cycle
نعطي حرارة وناخذ شغل

refrigeration cycle
نعطي شغل وناخذ حرارة

base on working fluid

gas cycle

Vapor cycles

closed cycle
open Cycle

internal Comburtion
(حريق جوه الآلة)

external
مصدر الحرارة خارجي
(عملية الاحتراق خارجية تحصل خارج الدورة)
والحرارة تدخل تشغل الدورة

دورات الهواء القياسية